for improved clinical assessment and convenient visual display of ischemia at rest and with stress echo.

939-114 Insights From Three-Dimensional Echocardiography Into the Mechanism of Functional Mitral Regurgitation: Direct In Vivo Demonstration of Leaflet Tethering Geometry

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Recent advances in three-dimensional (3D) echocardiography can allow us to address uniquely 3D scientific questions, such as the mechanism of functional mitral regurgitation (MR) in LV dysfunction. Competing hypotheses include global LV dysfunction with inadequate leaflet closing force vs geometric distortion of the mitral apparatus by LV dilatation, restricting leaflet closure. We addressed these possibilities by infusing esmolol and phenylephrine in 6 open-chest dogs to induce LV dysfunction, first limiting LV expansion by increasing pericardial restraint and then opening the pericardium. The 3D relations of the papillary muscle (PM) tips and valve were reconstructed from midsystolic rotated apical echo views, and MR stroke volume (SV) calculated as LV-forward aortic (flowmeter) SV. *Results:* 1) With pericardial restraint, despite EF = 17 ± 5%, only trace MR developed with mildly increased LV end-systolic volume. 2) With open pericardium, moderate MR developed as the LV dilated. 3) MR SV significantly correlated with the tethering distance from the PMs to the anterior annulus, especially posterior and medio-lateral PM shifts, as well as annular area ($p < 0.0005$). By multiple regression, the PM-to-annulus distance was the only significant independent predictor ($r^2 = 0.81$, $p = 4 \times 10^{-7}$). *Conclusions:* LV dysfunction without dilatation fails to produce important MR. Functional MR relates strongly to changes in the 3D geometry of the mitral valve attachments at the PM and annular levels, with practical implications for approaches that would restore a more favorable configuration.

939-115 Left Ventricular Volumes Measured from Intracardiac Echocardiography Images Using Novel Geometric Methods, Automated Border Detection and 3D Reconstruction

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Intracardiac Echocardiography (ICE) optimizes endocardial signals which facilitates quantitative assessment of regional wall motion, wall thickness and Left Ventricular (LV) volume measurements. Our purposes were first to determine LV volumes from ICE images by (a) the standard Simpson's rule method b) new geometric methods and c) a new automated border detection method for 3D reconstruction (3DR), and second, to compare calculated to displacement volumes. A 10 F, 10 MHz intracardiac ultrasound transducer was placed in the LV of 8 excised swine hearts suspended in a saline bath. Short axis views (SAX) of LV were obtained at 0.5 cm increments from apex to the mitral annulus. The four reconstruction models used were 1) Cylindrical discs 2) Trapezoidal discs 3) Ellipsoidal discs and 4) 3DR. The 3DR method generates fully automated computer determined endocardial and epicardial borders. LV volumes are calculated automatically from a shape-based interpolation of all cross sectional areas from the apex to the mitral valve annulus. The computed volumes from all methods were compared with the true displacement volumes measured. *Results:* The mean and standard deviation of the errors (displacement – calculated volume in cc) were 1) 1.28 ± 1.01, 2) 1.22 ± 1.14, 3) 1.18 ± 1.08, 4) 1.21 ± 1.11, respectively. True volume was significantly correlated with the ellipsoidal method, $y = 0.85x + 1.48$, $r = 0.93$, and the 3DR method, $y = 0.73x + 2.6$, $r = 0.93$. LV cross-sectional areas determined manually were highly correlated with automated computer defined areas, $y = 0.98-0.01$, $r = 0.97$. *Conclusion:* Images from an ICE catheter in the LV can be analysed by a precise 3DR method, which generates reliable automated cross-sectional areas of the LV endocardial surface, and provides accurate analysis of LV volumes. The new ellipsoidal and trapezoidal disc methods are as accurate as the traditional cylindrical disc methods.

939-116 Intracardiac Echocardiography Can Quantitatively Image the Left Ventricle from a Right Ventricular Transducer Position

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The left ventricle (LV) of canines and humans has been studied with intracardiac echocardiography (ICE). Usually ICE is performed with the ultrasound catheter in the chamber being studied because of limited depth of field. The availability of lower frequency ultrasound catheters may allow LV imaging from the RV – a more clinically attractive approach. Our purpose was to demonstrate that an ICE catheter placed into the RV can quantitatively image the LV and monitor changes in LV function. A 10 F, 10 MHz ultrasound catheter was placed into the RV of 10 closed chest swine via the right internal jugular vein. We evaluated global and regional LV response to dobutamine and balloon catheter coronary occlusion. Baseline and intervention LV cross sectional end diastolic and end systolic areas, and % of LV circumference with a wall motion abnormality (% Circ WMA) were measured. LV cross sectional area ejection fraction (Area EF) was calculated. Transthoracic echocardiography (TTE) was used as a comparison. *Results:*

Area EF	Baseline	Dobutamine	Coronary occlusion	% Circ WMA
ICE	0.73	0.89	0.48*	23
(SD)	(0.05)	(0.05)	(0.07)	(3)
TTE	0.80	0.91	0.53*	22
(SD)	(0.03)	(0.06)	(0.06)	(2)

*$p < 0.05$, vs baseline

There were no significant differences between ICE and TTE measurements. Thus, the LV can be quantitatively and accurately imaged from the RV using ICE in swine. ICE warrants clinical evaluation as a method for monitoring LV function in the catheterization lab and CCU.

939-117 Determination of Left Ventricular Aneurysm Surface Area by Dynamic Three-dimensional Echocardiography

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The Quantification of left ventricular aneurysm surface area (ASA), as a region of dysfunction, and total endocardial surface area (TESA) by two-dimensional echocardiography using geometrical algorithms is inaccurate, particularly in asymmetric left ventricles.

In order to detect the percentage of left ventricular dysfunction tomographic three-dimensional (3-D) echocardiographic (3-DE) quantification of ASA was performed in 21 patients (65 ± 8.3 yrs) and validated by tomographic 3-D magnet resonance image reconstruction (3-DMR). Dynamic 3-DE data sets were obtained by ECG and respiratory triggering (Echoscan/TomTec). Image acquisition was performed from a transthoracic apical view using a rotational motor device. ASA and TESA were calculated enddiastolicly (TESA-ED; ASA-ED [cm^2]) and endsystolicly (TESA-ES; ASA-ES [cm^2]). Therefore, ASA and TESA were obtained from tomographic cross-sectional slices by manual planimetry of the endocardial contour of the aneurysm and the complete endocardial contour. Areas were calculated from contour length and slice thickness (3 mm) using the disc method. *Results:*

	ASA-ED	ASA-ES	TESA-ED	TESA-ES
3-DE	23.5 ± 13.4	23.2 ± 13.8	143.2 ± 35.2	115.4 ± 37.1
Mean of Diff.	3.3	2.9	5.2	3.8
SD of Diff.	5.6	5.4	6.9	7.2

Diff. = 3-DE – 3-DMR

A good agreement between the results of 3-DE and 3-DMR was found. As mean size of ASA related to TESA we found 19.4 ± 10.8% endsystolicly and 16.3 ± 8.9% enddiastolicly. Absolute size of ASA was constant during left ventricular contraction.

Conclusions: Left ventricular ASA and TESA can be quantified accurately by dynamic 3-DE. Therefore, dynamic 3-DE may be the most appropriate method to quantify other dysfunctional areas, in particular infarct areas.

939-118 Do Alterations in Load and Cardiac Output Affect Regional Shape and Global Geometry of a Normal Left Ventricle? A Quantitative Echocardiographic Shape Analysis Study

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Ventricular cavity geometry is an important determinant of LV function. It is not known whether LV shape is influenced by loading conditions. Regional curvature (C) and Fourier analysis (FA) yield indices of regional and global LV shape. In 9 dogs we examined the effects of saline infusion (SL) and nitroprusside (NP) on regional and global LV geometry. Apical long-axis 2-D echo was done at baseline and after each intervention. Regional C of the septum (S), apex (A) and posterior wall (P), and Fourier Shape Power Index (FSPI) were measured in end-diastole (ED) and end-systole (ES). *Results:*

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